DESIGNING AN ARGUMENTATIVE DECISION-AIDING TOOL FOR URBAN PLANNING

AIPA: An Interface between multicriteria decision aiding and Argumentative frameworks

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Abstract:

Urban planning is an important issue for all cities. In order to meet the challenges of sustainable urban planning, we propose a participative decision-support tool that allows stakeholders to engage jointly in structuring a decision process, to identify alternatives, to construct criteria, to challenge their relevance and to evaluate them. The novelty in our approach is the use of an argumentative approach to support multicriteria decision aiding. The use of an argumentative framework allows the stakeholders to formalize the decision problem by taking explicitly into account the diverse opinions expressed and ensuring their traceability. Through the argumentative approach, our goal is thus to enhance participatory decision making by organizing and formalizing debates between stakeholders. To this effect, we propose AIPA, an interface the makes the transition between natural language and abstract argumentation systems. Our aim is to place debates at the center of the decision analysis process in order to facilitate the acceptance of the final decision by all parties.

Keywords:

Decision-aiding, urban planning, argumentative approach, participative decision, multicriteria decision analysis

1. INTRODUCTION

Urban planning is an important issue for all cities. The question is how to develop or redevelop a neighborhood, i.e. design buildings, green spaces and transportation infrastructures such as roads and tramway tracks. Urban planning projects must take advantage of the current state and invent the city of tomorrow while meeting the challenges of sustainable development. The many dimensions of sustainable development include social (creating a social link, ensuring a good living environment for the inhabitants, fulfilling spiritual needs, etc.), economic (limiting investment costs for the municipality, limiting costs for residents, limiting maintenance costs, etc.), environmental (limiting energy consumption, limiting impacts on wildlife, etc.), cultural (taking into account local particularities), spatial (paying attention to the territorial distribution of people), and ethical (pursuing fairness and equity principles). These different dimensions necessarily lead to contradictory objectives that must be reconciled in a decision process. Therefore, designing an urban planning project from a sustainable perspective while considering short, medium and long term impacts, is a quite complex endeavor. Furthermore, sustainable development implies other dimensions, such as governance and participation: sustainable development can only be achieved in consultation with the various stakeholders involved in decision-making, ideally leading to a wide consensus; a development project that generates strong opposition among local residents for example, could not be considered sustainable. Consequently, the various stakeholders involved such as the mayor, city council, urban planners, inhabitants, engineers, who may have different points of view and different objectives, must and can be included in the process (Joerin *et al.*, 2009; Rey-Valette *et al.*, 2007).

Many qualitative public participation approaches, based on dialogue to guide the actors to a final decision in public decision-making, have been used for urban planning (O'Faircheallaigh, 2010; Evans & Kotchetkova, 2009). These participatory approaches are interesting for many reasons: first, they involve a wide range of actors in the decision process; second, they make it possible to reach a decision closer to the values and concerns of each actor; and third they favor the final decision's acceptance by the actors, due to the transparency of the process. However, one of the main limitations reported on these approaches concerns their lower level of formalization and reproducibility (Hutchel & Molet, 1986). The lack of formalization limits the traceability of the decision; someone who wishes to understand the decision could, at best, refer to a report or a transcription of the discussions which is time consuming and probably not sufficient to understand the final decision. Moreover, this kind of approach does not generally provide information such as the global project ranking and the evaluation table that could help understand the rationale behind the choices made (e.g. values considered, project requirements, information available, consequences, etc.).

To go beyond these limitations, the scientific literature contains numerous formal decision support methods that have been used for urban planning, whether they are mono-criterion based such as benefit/cost analysis or multicriteria based. MultiCriteria Decision Aiding (MCDA) has been around for the last 50 years, resulting in a large number of methods and applications (Greco *et al.*, 2016). However, these methods often do not advocate a participative approach and assume that stakeholders have homogeneous preferences and are considered as a single decision-maker. Nonetheless, many multicriteria methods can be, and have been used in a multi-actor context, such as MACBETH (Bana E Costa, 2001; Marleau Donais *et al.*, 2017) or ELECTRE (Oberti, 2004) for example, where a facilitator conducts decision conferencing with several stakeholders. However, the focus is often not on the discussion process and on the arguments presented but rather on the construction of a common preference model through consensus. Consequently, it is difficult to explicitly integrate within the mathematical frameworks of these methods, the richness of the discussions between the actors as well as the problem's complexity (Ministère de l'Ecologie, du Développement durable, des Transports et du Logement: Paris, 2004). Moreover, the main challenge in using MCDA is undoubtedly the structuring phase since decision problems are often quite difficult to deal with, and alternatives and criteria are rarely readily available (Marttunen *et al.*, 2017; Belton & Stewart, 2010; Franco and Montibeller, 2010). Therefore, structuring and formalizing a decision problem to fit into a MCDA framework can be difficult, notably in a multi-stakeholder context where the following pertinent questions are justified at the end of the process:

- Are the criteria retained relevant for all the stakeholders?
- Are the alternatives constructed relevant for all the stakeholders?
- What does the common preference model represent?
- Where are the traces of the discussions pertaining to the previous questions?

In addition, the final recommendation obtained by a MCDA method could be also be subject to discussion: Is it really acceptable for all the stakeholders? Why was such a decision reached by the MCDA method? Does it really reflect the decision makers preferences? To address these questions, some argumentations technique for the explanation of MCDA results have been applied at a more theoretical level (Amgoud *et al.*, 2005; Labreuche, 2011).

Notwithstanding the approach that is used, there are, to our knowledge, no tools available to help organize the outcomes of discussions, in real time, in a way to ensure traceability, encourage more discussion, and provide the rationale behind the decisions made in a multiple criteria setting. In order to remedy this situation, particularly during the structuring phase of a MCDA process, we propose AIPA (Argumentation Interface for Participative Approach), a decision support tool for multi-actor, multi-criteria decision projects that allows us to formalize the natural language arguments exchanged, in order to challenge their relevance and to evaluate them in an argumentation framework.

Projects combining argumentation, MCDA and computational social choice have been successfully used in other application domains, especially concerning the sustainability of agriculture, food and environment systems, research (Bisquert *et al.*, 2017; Thomopoulos *et al.*, 2015). However, there are still no tools to date that have succeeded in combining decision-aiding technique with participatory argumentative approaches, making them operationally usable for urban planning.

Our main interest in developing AIPA is to assist the stakeholders in the structuring phase of the decision problem and in the final discussion about the solution proposed by MCDA. This approach is based on the dynamic modeling of arguments and on the explicit formalization of the opinions and preferences of the actors in order to conduct a transparent decision process and to arrive to a jointly constructed and acceptable decision. It is in line with the philosophy of computer-supported collaborative decision making (Scheuer *et al.*, 2010; Karacapilidis & Papadias, 2001).

By helping to capture arguments during a discussion in natural language and to translate them into formal arguments, AIPA is meant as a first step towards filling this gap. The formal arguments are then used in an argumentation framework implemented in AIPA, where semantics are used to infer a subset of collectively acceptable arguments, called extensions. Although applicable to any domain, the intended application of this project is urban planning.

The novelty of our approach resides in the use of an argumentative framework to take explicitly into account the diverse opinions expressed. Our goal is to enhance participatory decision support in general, and in urban planning in particular, through semi-automated argumentative and semantic approaches that help in organizing and formalizing discussions between stakeholders. The proposed tool is meant as an interface between natural language arguments and abstract argumentation frameworks, in which a collectively acceptable a set of arguments is identified. This combination of decision aiding and argumentative methods is in line with (Dix *et al.*, 2009) and (Simari *et al.*, 2011) who raise the pertinent questions of: "What does an argumentation-theoretic approach add over and above decision theory? How can one integrate argumentation tools with classical decision theory and other existing models of decision making?". Possible answers to these questions were proposed in Ouerdane *et al.* (2010) as research avenues.

The rest of this paper is organized as follows: in Section 2 we present AIPA and background concepts and definitions relating to argumentation frameworks. In Section 3, we describe how AIPA can support a MCDA process and illustrate its use using an example. We conclude in section 4 with future perspectives.

2. ARGUMENTATION IN AIPA

In order to evaluate the collective acceptance of arguments and reach a decision, argumentation frameworks introduced by Dung in his seminal paper (Dung, 1995) and the different frameworks derived from it, such as Value-based AF (Bench-Capon, 2003), (Dunne *et al.*, 2011), and (Amgoud & Ben-Naim, 2013) may be used. Argumentation frameworks are abstract argumentation models of argumentative discourse, used to confront conflicting arguments in order to arrive at a conclusion. Arguments are intuitively understood to be statements to support, contradict, or explain other statements that could be decisions or opinions (Amgoud & Prade, 2009). In a decision-making context of choice, an argument can support or reject a given option (Amgoud, 2009). An argument's conclusion can for example be that a given urban development project is rejected.

An argumentation framework is an oriented graph where nodes are arguments and edges are attack relations between arguments. In Dung's framework, an argument and the attack relation are abstract and can be differently instantiated and defined in different contexts (Walton, 2009). Quoting Dung (1995): "an argument is an abstract entity whose role is solely determined by its relations to other arguments. No special attention is paid to the internal structure of the arguments". An argument can for example be a set of statements composed of a conclusion and at least one premise, linked by an inference or a logical relation (Breton & Gauthier, 2000). Attacking an argument could be achieved by raising doubts about its acceptability through critical questions, by questioning its premises, or by putting forward that the premises are not relevant to the conclusion. Another way to attack an argument is by presenting an argument with an opposing conclusion. In this last case, when arguments support different conclusions, an attack relation is be said to exist. One application of a value-based argumentation framework to a real-life problem can be found in (Tremblay & Abi-Zeid, 2016) where a recommendation regarding the development of a hydropower plant was analyzed a posteriori. In that case, an argument was defined as a statement consisting of a premise and a conclusion, where a conclusion was one of three alternatives: accept the project, refuse the project, or accept the project with modifications.

Although theoretically relevant, the application of Dung's framework to real decisions is not straightforward. One of the main challenges resides in the definition of an argument. As discussed earlier, there is no general model to formalize a natural argument (i.e. an argument stated by a stakeholder during a discussion in its primal form) in order to be used in an abstract argumentation framework in a real decision-making context. In the words of Baroni & Giacomin (2009), « *While the word argument may recall several intuitive meanings, like the ones of "line of reasoning leading from some premise to a conclusion" or of "utterance in a dispute", abstract argument systems are not (even implicitly or indirectly) bound to any of them: an abstract argument is not assumed to have any specific structure but, roughly speaking, an argument is anything that may attack or be attacked by another argument.* » Furthermore, the notion of "attack between arguments" does not have a direct and consistent connection with natural language. In addition, the formalization of argument as an oriented graph can be difficult to understand by stakeholders. Indeed, the structure of the abstract argument and the relation between them do not correspond to the intuitive understanding of what an argument is. Furthermore, when the number of arguments and/or attacks is large, the graph becomes illegible and difficult to interpret by stakeholders.

In order to address the deficiencies described above, we developed AIPA as an interface between natural language arguments made by several stakeholders during discussions and an argumentation framework (Figure 1). AIPA is designed to: (a) consider different stakeholders, (b) consider contradictory objectives/criteria, (c) be usable by any argumentation framework, (d) favor discussion, (e) give immediate results to be used in the discussion (e.g., a list of criteria), (f) be easily understood by non-experts in mathematics and computer science. It gives a concrete meaning to an abstract argument by automatically translating natural language argument them into arguments usable by an argumentation framework. The aim is to allow stakeholders as end-users to argue in real-time with simple tools without having to learn argumentation frameworks.

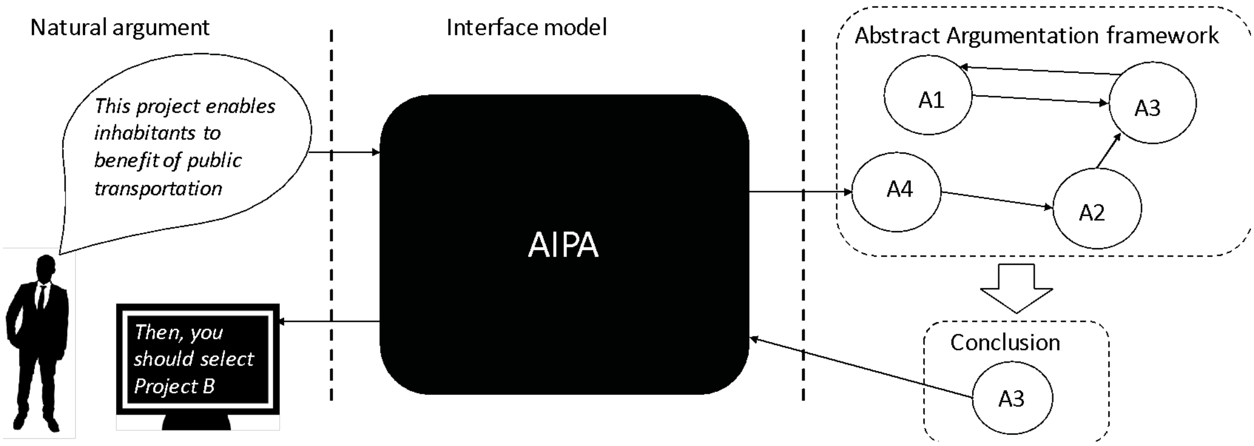

Figure 1: *Positioning of AIPA*

2.1. Argumentation Frameworks – Definitions

We present below some definitions and example to help understand how a set of collectively acceptable arguments can be reached based on Dung's formalism.

***Example 1**. Let AF be an argumentation framework (Figure 2) containing three arguments: a1, a2 and a3 with the following attack relation:*

- *a1 attacks a2*
- *a2 attacks a1*
- *a3 attacks a2*

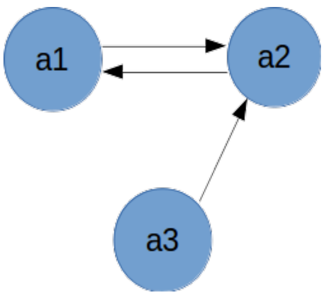

***Figure 2**: Attack graph*

Definition 1. A subset of arguments S is said conflict-free if and only if the arguments in S do not attack each other.

Example 2 *(Example 1 - continued). Since a1 and a3 that do not attack each other, the set S consisting of a1 and a3 is conflict-free.*

Definition 2. *An argument a1 is acceptable with respect to a set S of arguments if and only if for all arguments that attack a1, those arguments are attacked by at least an argument in S.*

Example 3. *(Example 2 - continued) Let S denote the set containing only a3, a1 is acceptable with regard to S since S attacks a2. S is then said to defend a1.*

Definition 3. *A set of arguments S is admissible if and only if S is conflict-free and each argument in S is acceptable with respect to S.* The empty set (without arguments) is always admissible.

Example 4. *(Example 3 - continued) Let S denote the set containing a1 and a3, S is admissible since a1 and a3 are acceptable with regard to S.*

A set of collectively acceptable arguments, according to a given semantic is called an extensions. Dung defined different types of semantics that yield extensions ("preferred", "stable", "complete", and "grounded") according to the properties expected from these extensions, i.e. those that should be considered to make a decision.

Definition 4. *A set S is a preferred extension of an argumentation framework if and only if S is admissible and maximal; a set S is maximal if S is not a subset of some other set.*

Example 5. *(Example 4 - continued) The set 1 is admissible and it is not a subset of another set; it is therefore a preferred extension.*

Definition 5. *A set S of arguments is a stable extension if and only if S is conflict-free and S attacks every argument that does not belong to it. A stable extension is a preferred extension, the reciprocal is false.*

Example 6. *The set S1 composed by a1 and a2 does not attack the argument a3; therefore, it is not a stable extension. However, the set S composed by a1 and a3 is a stable extension.*

Definition 6. *A set S is a complete extension if and only if S is admissible and each acceptable argument with respect to S belongs to S.*

Example 7. *The set S composed by a1 and a3 is an admissible set, and since every argument acceptable with respect to S belongs to S, S is a complete extension.*

Definition 7. *A set S is a grounded extension if it is the smallest complete extension (the one with the minimum number of arguments).* A grounded extension is unique and may be equal to the empty set.

Example 8. *(Example 7 - continued) Since there is only one complete extension, the set S composed by a1 and a3 is the grounded extension.*

Based on these extensions, Dung defines two inference rules in order to infer acceptable arguments: credulous and skeptical. In credulous inferences, an argument is accepted if it belongs to at least one preferred extension. In skeptical inferences, an argument is accepted if it belongs to the grounded extension (all preferred extensions). A dispute is said to be resoluble when the preferred extension is unique, since there is only one set of arguments capable of acceptance (Bench-Capon, 2003).

2.2. AIPA's Implementation

In AIPA, an argument is a concept representing a proposition (assertion) that can be either a Conclusion or a Statement (Figure 3). A conclusion is a particular proposition pertaining to a given decision. For instance, a conclusion could be "*The project A should be selected*", or "The value of project A on criterion j is equal to Very High". A statement is a proposition providing a justification why another argument is supported or not. Because a statement concept is still too broad, we formed two sub-concepts: StatementFor and StatementAgainst. For example, the StatementFor "*The project A encourages the use of public transportation*" supports the conclusion "*The project A should be selected*" and the StatementAgainst "*Project B is particularly deficient regarding waste management*" attacks the conclusion "*The project B should be selected*". A statement can be understood as a premise for a conclusion. Furthermore, a conclusion called Cneg is always created: it is the complementary of all the other conclusions. For instance, if two conclusions are "*Select the project A*" and "*Select the project B*", the conclusion Cneg corresponds to "*Select neither A, neither B"*.

When a Statement that is a StatementAgainst has an about relation with a conclusion or another statement, this relation is translated into an attack relation. A StatementFor with an about relation with a given conclusion X, will have an attack relation with all other conclusions, that are mutually exclusive with conclusion X. Two conclusions that are mutually exclusive will attack each other respectively. Otherwise, they will have no attack relation in the resulting argument graph.

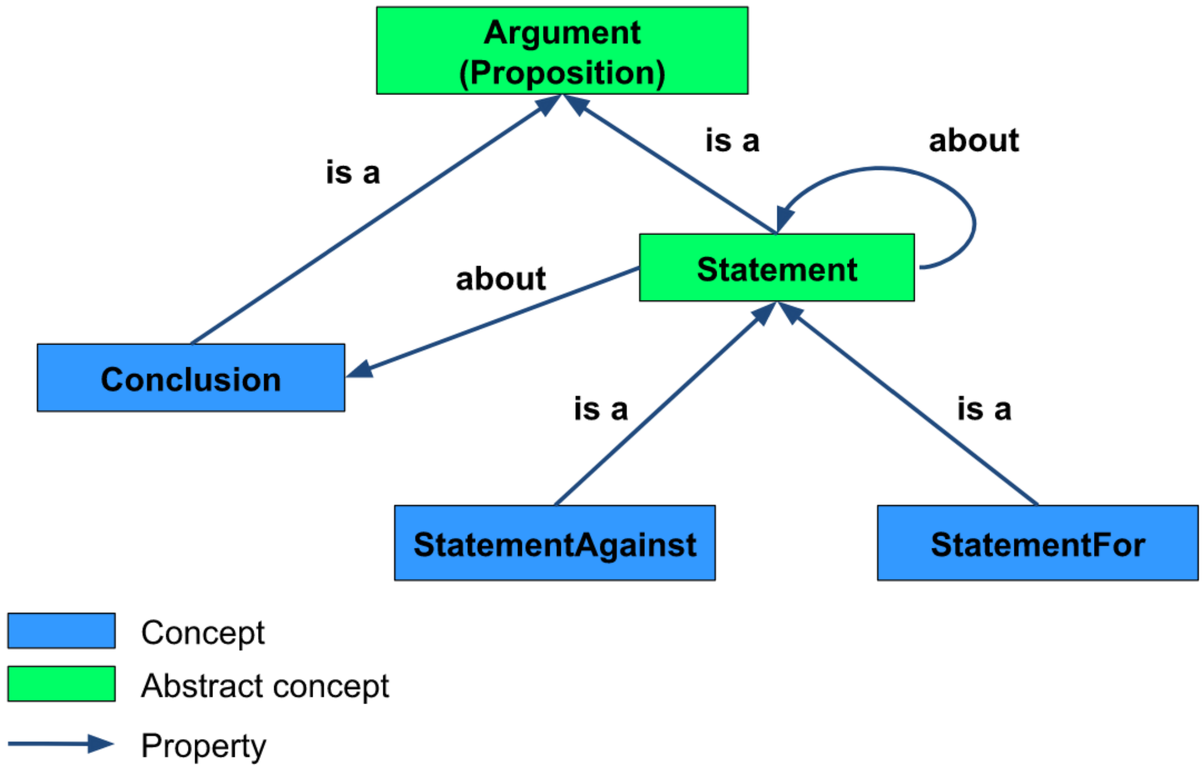

***Figure 3**: An argument model*

AIPA currently implements Dung's framework and the skeptical inference is used to obtain a solution: A solution is a subset of collectively acceptable arguments corresponding to the grounded extension. If no solution is found, meaning that the grounded extension is the empty set, the stakeholders have then two possibilities: (a) add new argument and/or (b) add/refine/modify a conclusion.

Consider a case with three conclusions A, B and C:

- A – *The cost of this project should be a criterion*
- B – *The project should start in January*
- C – *The project should start in February*

In this example, B and C are in conflict regarding a date, hence B will attack C, C will attack B and both of them will be attacked by and will attack a new Cneg conclusion "*The project should not start in January AND the project should not start in February*". On the other hand, the conclusion A does not compete with other conclusion except its own negation "*The cost of this project shouldn't be a criterion*", thus no attack will appear between A and the set {B,C}. As for the statements, if a StatementAgainst S1 is made about a conclusion such as A, it will be translated into an attack from S1 to A in Dung's framework. If a StatementFor S2 is made about a conclusion such as B, it will be converted into an attack from S2 to every conclusion that shares the same topic (in this case date, therefore attack of C and Cneg), except of the course for the conclusion that it supports (in this case B). If B is deemed acceptable instead of C, then the two conclusions A and B will be deemed acceptable (consensus) conclusions for the stakeholders involved. An argument is deemed acceptable if it belongs to the grounded extension (solution).

2.3 AIPA's Interface

The AIPA implementation allows the user to add an argument, to use an AF to make inferences in order to define the acceptable arguments and to present the result to the user. A given user puts forward an argument and specifies whether it is "for" or "against" another argument. Other users have the possibility to invalidate this argument by proposing a new StatementAgainst against it in the form of "*This argument is not valid*". The results presented to users is the solution consisting of the lists of acceptable arguments (grounded extension) and non-acceptable arguments (outside the grounded extension) in the form of a table and an argumentation graph. These operations are almost instantaneous, a necessary condition for use in real time by multiple users.

AIPA is a web application written in Java. This allows concurrent use with a multi-platform support. Moreover, the computing process is done on the server side and there are many javascript graphic libraries available that offer different views for the arguments. An example of the current implementation is given in Figure 4. It is a first prototype currently at a very basic level and will be improved in the future.

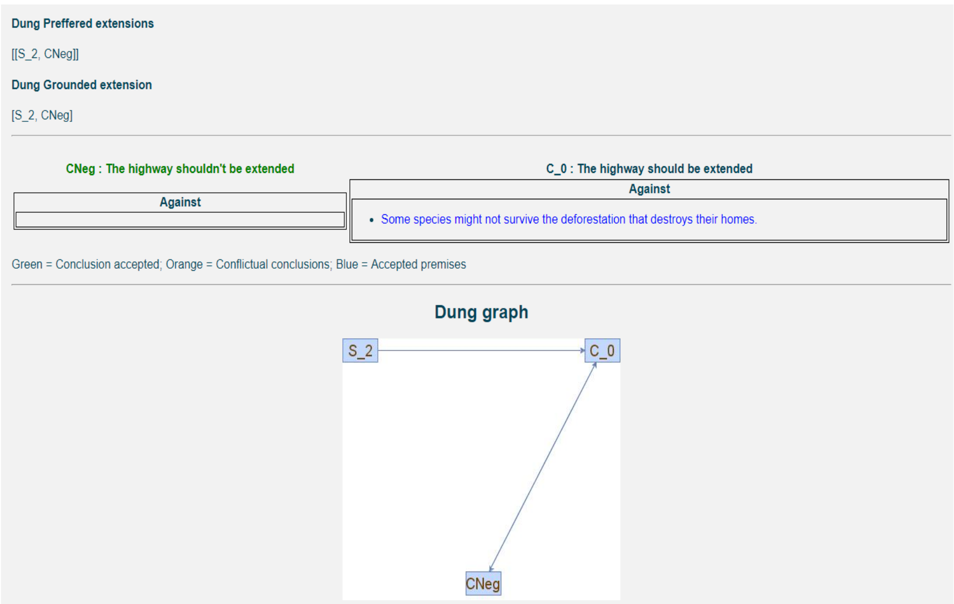

Figure 4: *Implementation of AIPA*

3. STRUCTURING A MCDA DECISION PROBLEM WITH AIPA

One of the objectives in developing AIPA is to provide support to the structuring phase of a MCDA process. Below, we illustrate with a simple example where AIPA can fit in the decision process and how it can support the stakeholders involved.

3.1. MCDA Structuration process

Discussions to help structure a multiple criteria decision problem consist mainly of three phases assuming that the different projects (alternatives) have already been defined and cannot be modified (Figure 5). In the first phase, the stakeholders construct the list of criteria. They can: (a) propose a new conclusion or refine an existing one (b) propose a statement for or against a conclusion. For example, for (a), if a stakeholder wished to add a new criterion "*Cultural*", he adds a new conclusion "*Use Cultural criterion*". An example of a new statement (b) is: "*Cultural is part of Social, it should not appear as a new criterion but as part of the already existing Social criterion*". Each time, a stakeholder proposes a new argument (statement or conclusion), AIPA provides the acceptable arguments (part of the grounded extension). The proposed list of criteria is constantly updated and presented to the stakeholders. We assume that project data regarding the different chosen criteria are available; for instance, if the project cost is considered as a criterion, it is possible to define the cost of each project.

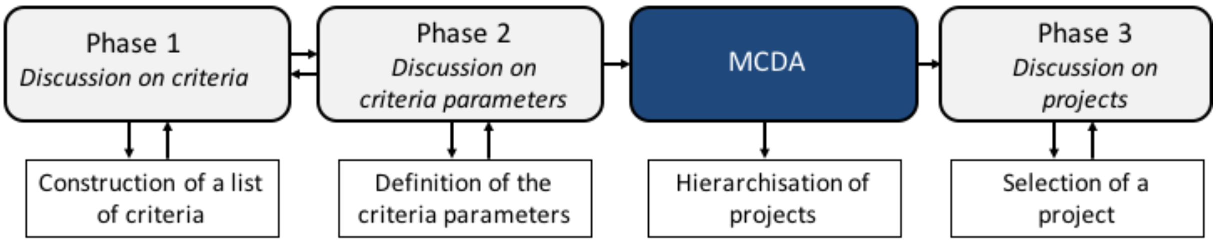

Figure 5: *A decision structuring model*

When all the stakeholders are in agreement regarding the list of criteria or if no one wants to propose new arguments, phase 2 can begin: it focuses on the criteria parameters (e.g. weight, thresholds, etc.). Globally, in this phase, the stakeholders have to propose conclusions enabling to compare criteria; for instance: "*Social should be privileged compared to economic criterion*". As in the previous phase, they can add new conclusion as a refinement of old ones or add statements. Based on the criteria preference and assuming that the evaluations of the alternatives on these criteria are possible, the projects can be then ranked by a MCDA method. In the last phase, the stakeholders may directly use the results of the MCDA method or add new statements (e.g. "The building of project A looks better than those of the project B which is ranked first). The final word is always given to the different stakeholders and must be the subject of a real discussion. The process is iterative. During the discussion, any actor can propose new arguments which may impact the acceptable solution (e.g. list of criteria, project ranking, etc.). The aim of this approach is to place the discussion at the center of the process in order to facilitate the acceptance of the final decision by all parties. In addition, it keeps the traceability of the reasoning that lead to a preferred project; any participant can, at any moment, read the arguments (close to natural language) and understand the choice of a conclusion. The two first phases are also iterative. If the comparison of the criteria in phase 2 reveals the need for a new criterion, it is always possible to return to phase 1.

In practice, the different phases correspond to meetings between stakeholders. Each phase does not necessarily correspond to one meeting; the number and duration of these meetings depend on the type of project, the number of stakeholders, etc.

3.2. An application example

In order to illustrate how AIPA can be used, we propose a simple example. Throughout this example, we assume a discussion about an urban planning project pertaining to a parcel at Pessac near the tram track with different stakeholders: the mayor (Mayor), the technical services managers (Tech), the directors of a citizen association (Citizen) and a person responsible of a nature protection agency (Nature). Five different development projects (projects A, B, C, D and E) are being considered.

The first discussion is about the criteria that should be used, and any person involved in the process can propose a conclusion. As Mayor puts forward the conclusion "*The cost should be a criterion*", Nature submits environmental and infrastructure aspects, respectively "*surface of green area*" and "*urban density*" as criteria. This primary exchange gives the following list of conclusions:

- Mayor: C1 - "*The cost should be a criterion.*"
- Nature: C2 - "*The surface of green areas should be a criterion.*"
- Nature: C3 - "*The urban density should be a criterion.*"

According to these three conclusions, three Cneg conclusions are automatically generated:

- AIPA: C1Neg - "*The cost should not be a criterion.*"
- AIPA: C2Neg - "*The surface of green areas should not be a criterion.*"
- AIPA: C3Neg - "*The urban density should not be a criterion.*"

Then, three premises are introduced by:

- Mayor: S1 - "*Since we only have 2 million € for this project.*" StatementFor -> C1.
- Nature: S2 - "*Green areas reduce the heat island effect.*" StatementFor -> C2.
- Tech: S3 - "*Higher density cities are more sustainable than low density cities.*" StatementFor -> C3.

At this stage, the three criteria are valid candidates (i.e. C1, C2 and C3 are acceptable according to the chosen inference) but Citizen is not in agreement with S3 and makes the statement:

- Citizen: S4 - "*High density buildings are not sustainable because they degrade the landscape and the quality of life*" StatementAgainst -> S3.

Since no-one is able to counter-argue Citizen by attacking S4, C3 is discarded. The criteria to be retained (solution) are: Cost (C1) and Nature (C2). This series of statements is shown on the left of Figure 6 and its translation (by AIPA) into an argument graph in Dung's framework is seen on the right of the figure.

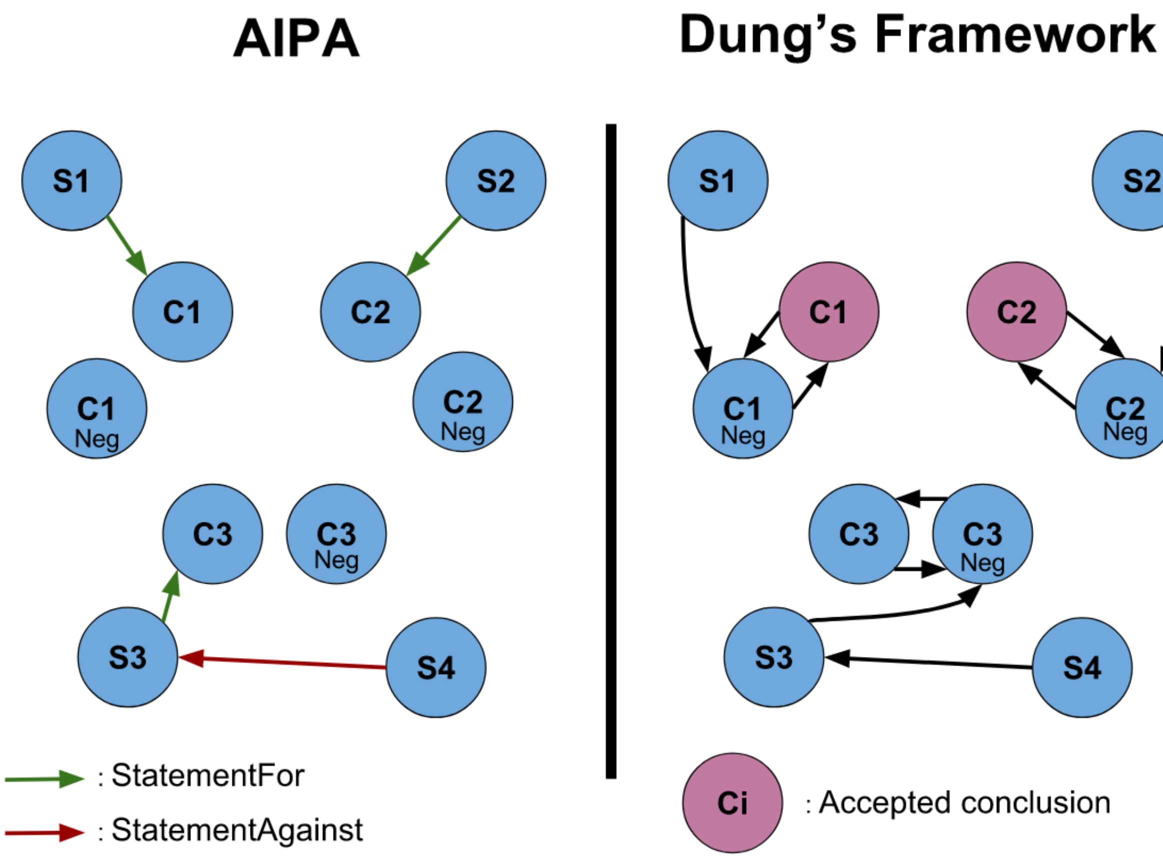

***Figure 6**: Criteria related graphs*

Following the criteria discussion is the criteria importance, to be used for example in an ordinal type MCDA method, and another instance is then created with no *a priori* conclusions. Assume that stakeholders provide the following conclusions:

- Tech: - C1 - "*Cost is as important as Surface of green areas.*"
- Mayor: C2 - "*Cost is more important than Surface of green areas.*"
- Nature: C3 - "*Cost is less important than Surface of green areas.*"

In this context, only one conclusion can be acceptable since they are all about the same topic (criteria preference) and are thus mutually exclusive: "Cost" and "Surface of green areas" comparison. The discussion results in different arguments (not given here), which yields C2 as the valid conclusion; *i.e.*

Cost is more important than Surface of green areas, as shown in Figure 7, we represent “Cost” with “++” and “Surface of green areas” with “+”.

Solution	Cost (M€)	Surface of green areas (km^2)
Project B	1.8	0.7
Project E	2.0	0.5
Project C	2.3	0.4
Project D	2.6	0.7
Project A	2.4	0.1

Figure 7*: Evaluation table*

Based on the evaluation table of Figure 7, project B appears as the best candidate. For simplicty’s sake, it is actually a dominant solution. However, given another evaluation table, it could have been ranked first based on an aggregation method. A new AIPA instance is made with two conclusions:

- AIPA: C1 - “*Project B should be selected.*”
- AIPA: CNeg - “*Another project should be selected.*”

A statementFor is automatically generated to support C1:

- AIPA: S1: “*The Project B is the best according to the evaluation and aggregation results.*” StatementFor -> C1

If no-one has new arguments, the decision process ends here. However, Tech thinks that project E should be retained since the security is better, and this element was not explicitly used as a criterion. Hence a new conclusion C2 is added as a new statement:

- Tech: C2 - “*Projet E is better.*”
- Tech: S1 - “*Project E ensures a better security.*” StatementFor -> C2

At this point, stakeholders can still provide counterarguments in order to attack or defend one of the projects or to question a previous statement. This follow-on discussion allows the participants to express their feelings and opinions on the projects, notably when they are difficult to formalize in a criterion (e.g. judgement on aesthetic). Discussions continue until a common agreement is found. If no consensus can be found with the help of the argumentation framework, the decision-maker(s) would have to resolve the dispute on the basis of other methods such as voting for example. This Phase 3 enhances the discussion during the decision process. Our basic assumption is that the final choice belongs to the stakeholders and not to the MCDA tool which role is to act as a support for reflection and discussion. Obviously, if all the stakeholders are in agreement with the MCDA results, then Phase 3 becomes unnecessary.

4. CONCLUSION

In this paper, we proposed an innovative approach that allows to: (a) use argumentation in a participative decision problem through a new model called AIPA and (b) couple argumentation with multicriteria decision analysis in order to support the problem structuring phase. AIPA is a model implemented in a computer tool that acts as an interface between natural language arguments and abstract argumentation frameworks. One of the main advantages of AIPA is that it does not alter the natural discussion structure. Another advantage is that it keeps a trace of the discussions in order to help justify choices that have been made thereby maximizing transparency. Our goal is to apply AIPA to support participative urban planning. Work is ongoing to develop a domain specific ontology to facilitate the use of AIPA in urban planning projects.

To our knowledge, this research project is quite novel and our approach is unique in urban planning. However, several points must to be improved and further developed: We are currently developing a decision making ontology that can automatically check the consistency of arguments and transform them into the underlying AIPA arguments model. Future work includes the implementation of the transition from AIPA to MCDA. Furthermore, we plan to use our tool in the next year to support participative city planning in Bordeaux Metropole. This real-life experience will be valuable and will provide us with many avenues for improving our tool. The feedback will allow us to assess the practical benefits and drawbacks of introducing formal argumentative approaches in multi-actor, multicriteria decision making.

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